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Short communication

First report on Cretaceous vertebrates from the Algerian Kem Kem beds. A new procoelous salamander from the Cenomanian, with remarks on African Caudata

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ABSTRACT

In northwestern Africa, the Kem Kem plateau is a major source of continental Cenomanian fossils. The plateau extends across the Algerian–Moroccan border but, unlike the intensely worked Moroccan part, the Algerian side of the Kem Kem beds has received less attention. However, recent field work in Algeria resulted in the recovery of a locality that yielded a promising vertebrate assemblage. Among the fossils is a trunk vertebra belonging to a salamander, a group whose remains are extremely rare in Africa. The vertebra is procoelous and it presents combination of characters that suggest it belongs to a new taxon of unknown affinities. Although the putative new taxon is represented by a single specimen that is too poorly preserved to be formally named, the discovery is important for showing that salamanders were more diversified than expected in the Cretaceous of Africa.

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1. Introduction

Caudata (i.e. salamanders) are primarily Laurasian amphibians (Bailon et al., 2011; Gardner and Rage, 2016). Most extant and extinct species occur in North America, Europe and Asia, which are the territories that made up the former Laurasia. These past and present ranges suggest that salamanders originated in Laurasia (Gardner and Rage, 2016). Outside of Laurasia, living salamanders occur only in the northern parts of three former Gondwanan continents (Frost, 2017): South America, the African Plate (Africa plus the Arabian Peninsula and Middle East) and India. The colonization of India does not appear problematic, because the Indian Plate has been in contact with Eurasia for a longer time (latest Cretaceous to early Eocene? Kapur and Khosla, 2016; Verma et al., 2016) than South America and Africa, both of which have been linked to Laurasia only recently, during the Neogene. The colonization of these two southern continents by modern salamanders appears to be a Neogene phenomenon. In Africa, fossils of both living and extinct taxa are known; they are rare but range from the Middle Jurassic to the Pleistocene (Gardner and Rage, 2016, and references therein).

Here we describe the first salamander from the Upper Cretaceous Kem Kem beds of Algeria. This specimen was collected from a locality known as Oued Bou Seroual.

2. African Caudata

A few fossils document the recent history of African Caudata. The earliest known of these fossils comes from the early Pleistocene of Morocco and was referred to as *Pleurodeles* cf. *waltl* (Bailon et al., 2011). *P. waltl* is a living species of European affinities, which is consistent with the Laurasian (Eurasian) origin for living salamanders inhabiting northernmost Africa. The date of dispersal of living salamanders into Africa is unknown, the only certainty is to assume that it is older than the early Pleistocene.

Aside from Pleistocene fossils, patchy older remains document a history clearly distinct from the recent colonization. They all come from the northern part of Africa and range from the middle Jurassic

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(Bathonian; Haddoumi et al., 2016) to the early-middle Eocene (Gardner and Rage, 2016). The relationships of these fossils are either unknown or disputed. Of particular importance are the remains from the Cenomanian–Santonian interval (Late Cretaceous) assigned to the endemic genus *Kababisha* (Evans et al., 1996) or to a closely related form, cf. *Kababisha* (Rage and Dutheil, 2008; Gardner and Rage, 2016). Their presence in the Late Cretaceous of Africa was regarded either as the result of vicariance (Rage et al., 1993) or of a dispersal from Laurasia (Evans et al., 1996). Here, we report on a new specimen from the Cenomanian of Africa, which likely represents a salamander distinct from *Kababisha*.

3. The Algerian Kem Kem and the fossiliferous locality

The Kem Kem plateau of Algeria is located in the western part of the Saharan platform at the junction between the mountain chain of Ougarta and the Moroccan Anti-Atlas (Zellouf, 1987) (Fig. 1A). The name Kem Kem has a Berber origin meaning torn or shredded (Lavocat, 1954); the name Hammada is also used, which means a vast and rocky plateau. This plateau is almost tabular with a slight inclination to the north, it is semi-desertic and excavated by a very dense river network (Joly, 1962). It is 200 km long extending NE to SW from the village of Taouz in southeastern Morocco, to the village of Zegdou in southwestern Algeria (Joly, 1962) (Fig. 1B). It is located approximately 1400 km southwest of Algiers and 350 km southwest of Bechar (Fig. 1A).

The wadis (i.e., rivers) that incise the surface of the Kem Kem as a dense network typically are not deep enough to expose the underlying marlstones and sandstones. In the Oued Bou Seroual area, however, the wadi Daoura does cut into the sandstone layer. A deposit rich in disarticulated micro-vertebrates was recovered recently in this region. It is situated in the central part of the Kem Kem plateau, 90 km northeast of Zegdou and 50 km east of the famous Gara Sbaa locality (Cenomanian, Morocco; Lavocat, 1948; Cavin et al., 2010) (Fig. 1B). The preliminary and unpublished list of vertebrates includes: Chondrichthyes (*Onchopristis dunklei*, *O. numidus*), Actinopterygii (Polypteriformes, Semionotiformes), Actinistia, Dipnoi, Amphibia (Anura), Squamata, Crocodylomorpha, Sauropoda, Theropoda, Pterosauria and, as reported here, a salamander.

4. Geological setting

The Cretaceous series of the Hammada, along the Algerian–Moroccan border was first and briefly described, on the Moroccan side, by Clariond (1933) during field work throughout the Hammada of Taouz. He described the following succession, from bottom to top: 120 m thick whitish and pinkish soft sandstone; 3 m thick calcareous sandstone with crystals of calcites and manganese spots, attributed to the Albian on the basis of the presence of the echinoderm *Dorocidaris taouzensis*; and a thick layer of limestones, which he divided into two parts, a lower part assigned to the Cenomanian, due to the presence of the ammonite *Neolobites vibrayanus*, and an upper part dated as Turonian on the basis of the presence of the gastropod *Nerinea requieni*.

Later Choubert (1948), Lavocat (1948, 1954), and Dubar (1949) divided the Kem Kem beds into three formations: a lower continental formation commonly called 'Grès infracénomanien' or 'Formation d'Ifezouane' assigned to the Albian (Choubert, 1948; Dubar, 1949; Ettachfini and Andreu, 2004); a second, lagoonal formation composed of colorful marlstones with gypsum, assigned to the lower Cenomanian and called 'Marne versicolore à gypse' (Choubert, 1948) or 'Formation d' Aoufous' (Dubar, 1949); and a third, marine formation of Cenomanian–Turonian age, comprised of white marly-limestones including flints, called 'Formation d'Akrabou' (Dubar, 1949).

Sereno et al. (1996) united the two lower formations of Dubar (1949), namely the Ifezouane and Aoufous formations into a single unit informally named the 'Kem Kem beds'. The Kem Kem beds were assigned to the lower Cenomanian (Sereno et al., 1996; Cavin et al., 2010) on the basis of close similarity between the vertebrate assemblage of these beds and that of Bahariya, in Egypt (Catuneanu et al., 2006).

The Kem Kem beds in Oued Bou Seroual, Algeria, are reported here for the first time and consist mainly of sandstone. The lower part includes thin reddish sandstones and yellowish coarse sandstones, overlaid by reddish coarse sandstones; all these sandstones show oblique and horizontal stratifications. The upper level comprises yellowish coarse sandstones interspersed with greenish coarse friable sandstone; this is the richest level in terms of the number of vertebrate fossils.

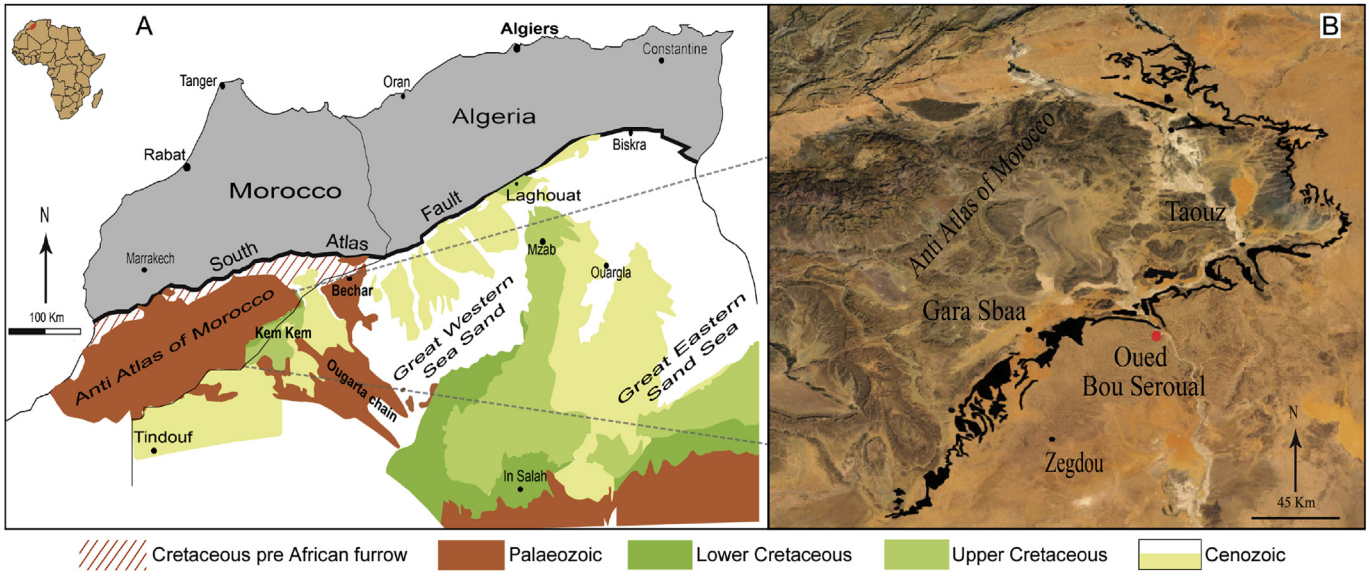

Fig. 1. A, geographical location of the Kem Kem plateau (grey area not mapped); modified from Benyoucef (2012). B, Satellite image of the area, with location of Oued Bou Seroual area, marked by a red dot. Image from Google Earth. (For interpretation of the references to color in this figure legend, the reader is referred to the web version of this article).

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